



UNIVERSITI PUTRA MALAYSIA

***PHYSICAL AND RHEOLOGICAL PROPERTIES OF RED TILAPIA
(OREOCHROMIS NILOTICUS LINNAEUS) MINCE FOR DEVELOPMENT
OF SPRAY-DRIED FISH POWDER***

MD AKHTER UZZAMAN

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(*OREOCHROMIS NILOTICUS* LINNAEUS) MINCE FOR DEVELOPMENT
OF SPRAY-DRIED FISH POWDER**

By

MD AKHTER UZZAMAN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

March 2012



Dedicated to
My parents, my beloved wife and daughter

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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(*OREOCHROMIS NILOTICUS* LINNAEUS) MINCE FOR DEVELOPMENT
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March 2012

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Faculty : Food Science and Technology

In order to examine the potential of utilizing whole mince of red tilapia (*Oreochromis niloticus*) powder as surimi or surimi based products, the effect of various additives such as potato starch (PS) (5-25%), sago starch (SS) (5-25%), chitosan (0.4-2.0%) and sodium tripolyphosphate (TPP) (0.05-1.0%) on the gelation related properties as well as on the thermal and rheological behavior were evaluated. The most promising additive for improving tilapia mince meat gelation properties was identified and the tilapia slurry was then spray dried and optimization was carried out using response surface methodology. The effect of inlet and outlet temperatures and maltodextrin concentration on the gelling capacity, colour, moisture content and water activity of the fish powder were determined. The texture and colour properties of tilapia mince paste was improved by the addition of chitosan>potato starch>sago starch>TPP. More elastic gel was obtained in kamaboko type gel containing 0.4% chitosan. For directly heated gels, gel with 1.2% chitosan exhibited the highest springiness property, followed by 10% potato starch. Harder

gels were obtained for PS or SS compared to chitosan and TPP. Chitosan at 0.4% produced kamaboko gel with higher L^* value (lightness), low b^* value (yellowness) and higher whiteness index compared to others. Similar effect by chitosan was recorded in directly heated gels for 0.8% and 1.6% incorporation. The presence of starch and/or TPP either decreased or did not have any effect on the lightness, yellowness or whiteness values of gels. The differential scanning calorimetry (DSC) trace of tilapia mince paste showed two zones of sharp endothermal effects with T_{max} of 52.2°C and 68.48 °C for the thermal denaturation of myosin and actin, respectively. The addition of 20-25% PS and 15% SS in tilapia mince resulted in thermal stability of myosin but not affecting actin. Starch addition significantly ($p < 0.05$) lowered the denaturation temperature of myosin. The tilapia mince paste without additive exhibited good elastic properties with high value of G' (6.6 kPa) and was further enhanced by the addition of the additives. The additive incorporated tilapia mince complex had $G' > G''$. Storage moduli (G') increased with 5- 10% PS and 20-25% SS, whereas the elastic behavior of tilapia mince paste could also be improved by the addition of 0.05% TPP and 0.4% chitosan. Chitosan at 0.4% was chosen as the best additive for the production of tilapia meat powder. For spray drying, fish meat slurry was prepared with 0.4% Chitosan, 5 mM Calcium chloride, NaHCO_3 and 5% w/w sorbitol. The optimized spray-drying conditions were found to be at the inlet temperature of 181.15°C and outlet temperature of 98.45°C with addition of 27.64% maltodextrin. The predicted optimum value of multiple response under optimal conditions were the least gelation concentration at 8.55%; whiteness at 88.19, moisture content at 2.65%, and water activity at 0.21 with a desirability function value of 0.885. The produced powder had whiteness value of approximately 97.69% moisture content of 2.63 gelling capacity at 8.67 and water activity of 0.255.

The Spray-dried tilapia mince powder produced under the optimized conditions were evaluated for their storage stability at 4°C, 10°C, 30°C, 40°C and 60°C for a period of three months. The half-life of the spray-dried tilapia powder kept at 10°C, ambient temperature ($30\pm 2^\circ\text{C}$) and at 40°C were predicted to be approximately fourteen months, five months and two and half months, respectively.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**SIFAT FIZIKAL DAN RELOGI IKAN TILAPIA CINCANG BAGI
PEMBUATAN SERBUK (*OREOCHROMIS NILOTICUS* LINNAEUS)
MENGUNAKAN PENYEMBUR KERING IKAN**

Oleh

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Pengerusi : Profesor Jamilah Bakar, PhD
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Bagi mengenalpasti potensi penggunaan tepung isi ikan tilapia merah (*Oreochromis niloticus*) sebagai surimi atau produk berasaskan surimi, Kesan pelbagai bahan tambah seperti kanji ubi kentang (PS) (5 -25%), kanji sago (SS) (5 – 25%), *chitosan* (0.4 – 2.0%) dan natrium tripolifosfat (TPP) (0.05 – 1.0%) ke atas pengelatan, ciri haba dan reologi isi ikan cincang dikaji. Bahan tambah yang terbaik dalam memperbaiki ciri pengelatan telah dikenalpasti dan cecairan tilapia kemudiannya dikering sembur dan pengoptimuman telah dilakukan menggunakan kaedah Response Surface Methology. Kesan suhu masuk dan keluar dan kepekatan malodextrin ke atas kapasiti pengelatan, warna, kandungan lembapan dan aktiviti air serbuk ikan telah ditentukan. Sifat tekstur dan warna pes tilapia cincang telah diperbaiki dengan penambahan *chitosan* > kanji ubi kentang > kanji sago > TPP. Gel yang lebih elastik telah diperolehi dari gel kamboko yang mengandungi 0.4% *chitosan*. Untuk gel yang olipanas terus, gel yang ditambah dengan 1.2% *chitosan* menunjukkan ciri

kekenyalan yang tertinggi, diikuti dengan 10% kanji ubi kentang. Gel yang lebih keras telah diperolehi dari PS atau SS berbanding dengan chitosan dan TPP. Penambahan 0.4% chitosan telah menghasilkan gel kamaboko dengan nilai L^* (kecerahan) yang lebih tinggi, nilai b^* (kekuningan) yang rendah dan indeks keputihan yang lebih tinggi berbanding yang lain. Kesan yang sama pada chitosan telah direkodkan bagi gel dipanas yang terus yang mengandungi chitosan 0.8% dan 1.6%. Kehadiran kanji dan/atau TPP menyebabkan ada penurunan atau tidak memberi kesan ke atas nilai kecerahan, kekuningan atau keputihan gel. Kalorimetri imbasan perbezaan pes tilapia menunjukkan dua zon kesan endoterma yang tajam dengan T_{max} sebanyak $52.2^{\circ}C$ dan $68.48^{\circ}C$ untuk terma penyahaslian miosin dan aktin, masing-masing. Penambahan 20 – 25% PS dan 15% SS ke dalam pes ikan menghasilkan kestabilan terma miosin tetapi tidak memberi kesan kepada aktin. Penambahan kanji merendahkan suhu penyahaslian miosin secara signifikan ($p < 0.05$). Pes tilapia tanpa bahan tambah menghasilkan ciri – ciri reologi yang baik dengan nilai G' (6.6 kPa) yang tinggi dan ini ditambah baik dengan penambah. Pes tilapia yang mengandungi bahan tambah mempunyai nilai $G' > G''$. Modulus penyimpanan (G') bertambah dengan 5 – 10% PS dan 20 – 25% SS, manakala, sifat kenyal pes tilapia boleh diperbaiki dengan penambahan 0.05% TPP dan 0.4% chitosan. Penambahan chitosan 0.4% telah dipilih sebagai bahan penambah yang terbaik untuk menghasilkan serbuk tilapia. Bagi pengeringan sembur, isi ikan cecairan ikan disediakan dengan campuran 0.4% chitosan, 5 mM kalsium klorid, a $NaHCO_3$ dan 5% sorbitol dan melalui pengering semburan. Kondisi yang optimum untuk pengeringan sembur adalah pada suhu masuk $181.15^{\circ}C$ dan suhu keluar $98.45^{\circ}C$ dengan penambahan 27.6% maltodekstrin. Nilai jangkakan ransangan berganda yang optimum di bawah keadaan yang optimum ialah 8.55% pengelasan

minima 88.2% keputihan, 2.65% lembapan dan 0.21% aktiviti air dengan nilai fungsi yang dikehendaki ialah 0.88%. Serbuk tepung isi ikan tilapia dihasilkan mempunyai nilai keputihan lebih kurang 97.69%, nilai kelembapan 2.63%, kapasiti pengelatan 8.67% dan aktiviti air sebanyak 0.255. Serbuk isi ikan tilapia yang dibawah parameter proses yang optimum telah dinilai kestabilan penyimpananyo pada suhu 4°C, 10°C, 30°C, 40°C dan 60°C Selama tiga bulan. Separuhhayat tepung isi ikan tilapia yang disimpan pada suhu 10 °C, ambien (30±2°C) dan 40°C adalah dijangka masing-masing bersamaan dengan empat belas bulan, lima bulan dan dua setengah bulan.

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I certify that an Examination Committee has met on 28/03/2012 to conduct the final examination of Md. Akhter Uzzaman on his PhD thesis entitled “physical and rheological properties of red tilapia (*oreochromis niloticus linnaeus*) mince for development of spray-dried fish powder” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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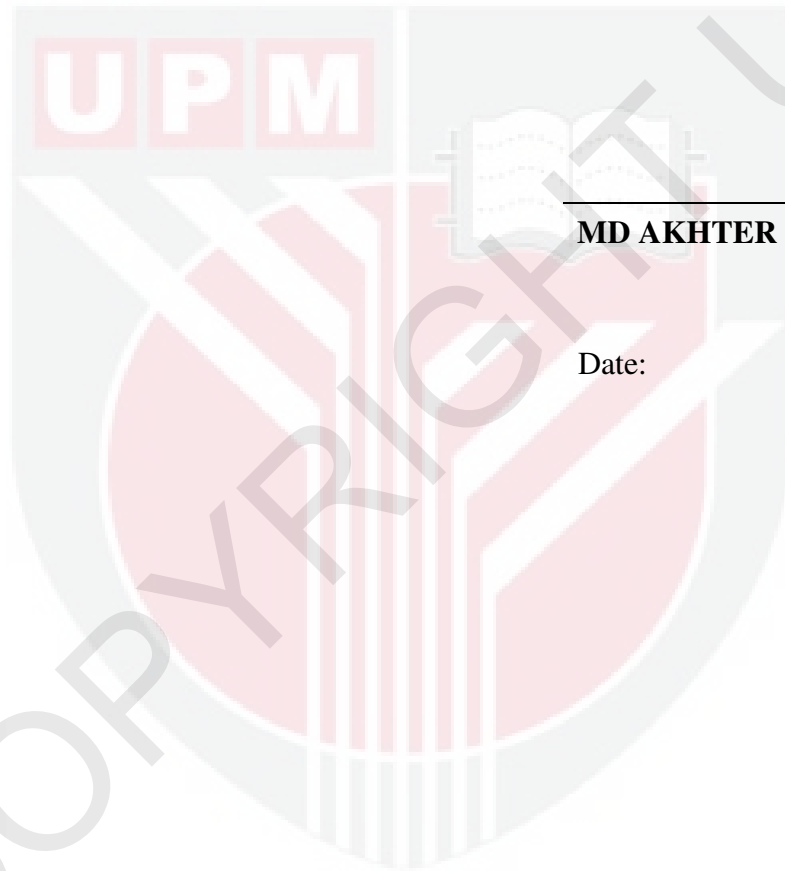
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DECLARATION

I declare that the thesis is my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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